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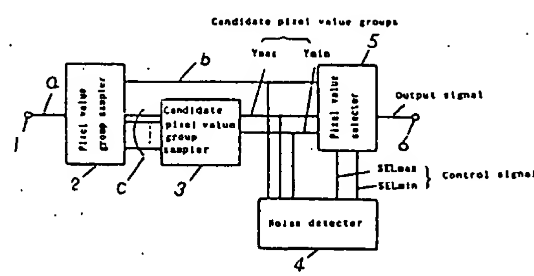
(54) Pixel defect removing circuit for solid-state image pickup device.

(57) From an input video signal, a pixel value of a pixel of notice noted at a certain time t and a proximal pixel group adjacent two-dimensionally around the pixel of notice are sampled, and maximum and minimum values from the proximal pixel value group are selected as candidate pixel value group, and by performing specific operation between the pixel value of the pixel of notice and the candidate pixel value group, it is judged whether a pulse noise is contained in the pixel of notice or not, and on the basis of the judgement, a pixel value is selected from the pixel value of the pixel of notice and the candidate pixel value group and delivered.

Fig. 1



EP 0 496 573 A1

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The present invention relates to a circuit for removing pulse noise components superposed on a video signal delivered from a solid-state image pickup device having pixel defect.

In image pickup devices such as video camera, recently, solid-state pickup devices are often used in the optoelectric conversion unit. When the output signal of the solid-state image pickup device is displayed by a monitor device and the video signal is observed, pixel defects known as white spots or black spots are sometimes observed in the picture. Such pixel defects are very obvious even if they are small in size, and the pickup device with pixel defects cannot be used as a commercial product, so that the yield is lowered. Besides, pixel defects can occur even after shipping of products. These problems are peculiar to the solid-state image pickup device, and are serious obstacles for using the solid-state pickup device.

Hitherto, as the means for solving the above problems, in a first example, as shown in U.S. Patent No. 460524, onset positions of pixel defects are stored in a PROM or the like, and the pixel defects are corrected by using the preceding and succeeding pixels on the scanning line at the timing when the output of the solid-state image pickup device corresponds to the stored position in the PROM.

In the first prior art, the PROM is required as the means for storing the position of pixel defects, but since the position of pixel defect occurring in the solid-state pickup device varies device by device, and it is necessary to investigate the pixel defect position in each device and prepare a corresponding PROM, which takes to much labor. Further, this method is useless for pixel defects occurring after shipping of products.

As a second example, as disclosed in the Japanese Laid-open Patent Application Sho. 61-261974, pixel defects are detected by comparison with the adjacent pixels positioned in the scanning line direction or in the direction vertical to the scanning line direction with respect to the pixel of notice, and the signal value is replaced by the value of one pixel before or the mean value of the preceding and succeeding pixels, so that the detected pixel defect is corrected.

In the second prior art, when detecting pixel defects, attention is paid only to the scanning line direction or the direction vertical to the scanning line direction, but as far as not compared with the pixels in oblique directions, fine line segments in oblique directions to the scanning line are detected as pixel defects, and all line segments in oblique directions may be removed. When correcting pixel defects, the value is replaced by one pixel before or the mean value of preceding and succeeding pixels, but if there is a pixel defect on a fine line segment extending in the vertical direction to the scanning line direction, the line segment may be cut off as a result of correction.

It is hence a primary object of the invention to present a device for favorably removing pulsive pixel defects existing only on one pixel, without removing the fine line segments in oblique directions to the scanning line direction and without sacrificing the fine line segments extending in the vertical direction to the scanning line direction, being effective to pixel defects occurring after shipping of products, and without requiring fabrication of PROM corresponding to each device.

To achieve the above object, the invention presents a pixel defect removing circuit which comprises a pixel value group sampler for receiving a video signal, and delivering a pixel value of a pixel of notice noted at a certain time t and a group of proximal pixel values consisting of pixel values of proximal pixels adjacent two-dimensionally around the pixel of notice, a candidate pixel value group sampler for delivering a group of plural candidate pixel values as candidates of pixel values to be finally delivered from the circuit out of the group of proximal pixel values, a noise detector for performing an operation between the pixel value of the pixel of notice and the candidate pixel values to judge whether a pulse noise is included in the pixel of notice or not, and delivering a pixel selection signal to instruct which pixel value should be delivered out of the pixel value of the pixel of notice and the candidate pixel values on the basis of the result of judgement, and a pixel value selector for selecting and delivering either one pixel value out of the pixel value of the pixel of notice and the candidate pixel values on the basis of the pixel selection signal.

In this constitution, the pixel value group sampler may preferably pick up pixel values of 3 x 3 pixels out of three continuous scanning lines, and define a central pixel as the pixel of notice and the remaining pixels as the proximal pixels. Besides, the candidate pixel value,group sampler may preferably deliver, as the candidate pixel values, two pixel values possessing a maximum pixel value and a minimum pixel value, respectively, in the proximal pixels. Meanwhile, the candidate pixel value group sampler may preferably deliver, as the candidate pixel values, two pixel values possessing a maximum value between Po and a smaller one of Pr and P1, that is, max (min (Pr, P1), Po), and a minimum value between Po and a larger one of Pr and P1, that is, min (max (Pr, P1), Po), among the proximal pixels, supposing a pixel value of a pixel existing at the closest position in a pixel group existing in the right direction on a scanning line containing the pixel of notice to be Pr, a pixel value of a pixel existing at the closest position in a pixel group existing in the left direction on the scanning line to be P1, and pixel values of pixels excluding Pr and P1 from the proximal pixels to be Po.

This constitution, not requiring to prepare a PROM corresponding to each device, is effective to pixel defects occurring after shipping of products, and

makes it possible to favorably remove pulsive pixel defects existing on one pixel only, without removing the fine line segments in the oblique direction to the scanning line and without sacrificing the fine line segments extending in the vertical direction to the scanning line.

Fig. 1 is an entire configuration in an embodiment of the invention.

Fig. 2 is a configuration of a pixel value group sampler in an embodiment of the invention.

Fig. 3 is a configuration of a candidate pixel value group sampler in a first embodiment of the invention.

Fig. 4 is a configuration of a noise detector in an embodiment of the invention.

Fig. 5 is a configuration of a pixel value detector in an embodiment of the invention.

Fig. 6 is a configuration of a candidate pixel value group sampler in a second embodiment of the invention.

Fig. 7 is a layout diagram of pixel of notice and proximal pixel group in one embodiment of the invention.

Fig. 8 is an operation explanatory diagram in the first embodiment of the invention.

Fig. 9 is an operation explanatory diagram in the second embodiment of the invention.

Referring now to the drawings, one of the embodiments of the invention is described in detail below.

In Fig. 1, a pixel value group sampler 2 receives a video signal a entered through an input terminal 1, and delivers a pixel value b of the pixel of notice, and a proximal pixel value group c consisting of pixel values of NxM-1 pixels excluding the pixel of notice from the pixel group adjacent two-dimensionally for N pixels in the scanning line direction about the pixel of notice and M lines in the direction orthogonal to the scanning line.

Fig. 2 is a specific configuration diagram of the pixel value group sampler 2. In Fig. 2, it shows an example of composition of M=N=3 in the explanation of operation of the pixel value group sampler 2, which is composed of two vertical delay units and six horizontal delay units. The horizontal delay unit is intended to deliver a signal by delaying the input signal by the scanning time for the portion of, for example, one pixel, while the vertical delay unit is designed to deliver a signal by delaying the input signal by one horizontal scanning time. Meanwhile, Fig. 7 shows a layout example of the pixel of notice on the scanning line and proximal pixel group, in which pixels numbered from 1 to 8 compose the proximal pixel group c, and the pixel of notice b is located in the center of the proximal pixel group.

In Fig. 2, the video signal a is connected to a horizontal delay unit 11, and the output of the horizontal delay unit 11 is connected to a horizontal delay unit 12. When signals are taken out from three positions, that is, the input end of the horizontal delay unit 11, the output end of the horizontal delay unit 11, and the output end of the horizontal delay unit 12, pixel values c3, c2, c1 at positions corresponding to proximal pixels 3, 2, 1 in Fig. 6 are obtained, respectively. The video signal a is also connected to a vertical delay unit 17, and when horizontal delay units 13, 14 are connected in series to the output end of the vertical delay unit 17, similarly, pixel values c5, b, c4 at the positions corresponding to the proximal pixel 5, pixel of notice and proximal pixel 4 in Fig. 6 are obtained. Furthermore, at the output end of the vertical delay unit 17 in Fig. 2, a vertical delay unit 18 is connected, and when horizontal delay units 15, 16 are connected in series to the output end of the vertical delay unit 18, similarly, pixel values c8, c7, c6 at positions corresponding to proximal pixels 8, 7, 6 in Fig. 6 are obtained. When the pixel value group sampler is composed in this manner, the pixel value b of the pixel of notice and the proximal pixel value group c may be delivered simultaneously from plural output terminals.

In Fig. 1, the candidate pixel value group sampler 3 delivers a candidate pixel value group from the proximal pixel value group c delivered simultaneously from the pixel value group sampler 2. The candidate pixel value group is composed of two pixel values, Ymax and Ymin, supposing the maximum pixel value in the proximal pixel value group c to be Ymax and the minimum pixel value to be Ymin.

Fig. 3 is a specific configuration of the candidate pixel value group sampler 3. Fig. 3, in conjunction with the explanation of the pixel value group sampler 2, shows an example of composition of candidate pixel value group sampler 3 in which the proximal pixel group is composed of 8 pixels, comprising a maximum value circuit 22 having eight input terminal groups and a minimum value circuit 23 having eight input terminal groups. The maximum value circuit 22 samples and delivers the maximum pixel value (Ymax) out of the input proximal pixel value group c. The minimum value circuit 23 samples and delivers the minimum pixel value (Ymin) out of the input proximal pixel value group c.

In Fig. 1, the noise detector 4 judges if noise is contained in the pixel of notice or not, from the pixel value b of the pixel of notice delivered from the pixel value group sampler 2, and Ymax and Ymin delivered from the candidate pixel value group sampler 3, and delivers the result of judgement as control signal. The control signal is composed of SELmax which is a signal for selecting Ymax, and SELmin which is a signal for selecting Ymin.

Fig. 4 is a specific configuration of the noise detector 4, which is composed of two subtractors, two comparators, and two threshold setters. A subtractor 33 subtracts Ymax from the pixel value of the pixel of notice, and generates the difference (hereinafter DIFmax). A comparator 34 compares DIFmax with the threshold value delivered from a threshold generator

35 (THmax hereinafter), and makes active the signal SELmax for selecting Ymax if DIFmax > THmax as Condition 1, and makes SELmax inactive if Condition 1 is not established. A subtractor 36 subtracts the pixel value of the pixel of notice from Ymin, and generates the difference (DIFmin). A comparator 37 compares DIFmin with the threshold value delivered from a threshold generator 38 (THmin), and makes active the signal SELmin for selecting Ymin if DIFmin > THmin as Condition 2, and makes SELmin inactive if Condition 2 is not established.

Generally, due to the spatial low pass filter effect by lens or the like, the amplitude of the high frequency component (detail) of the video signal as the output of optoelectric conversion element is small, and if pulse noise is not contained in the pixel of notice, the differential portion of the proximal pixel group with respect to the pixel of notice becomes small. Therefore, if THMax and THmin are set extremely small for the maximum value of pixel value, the detail component of the video signal may be lost, or if set extremely large, the defect itself cannot be detected, and hence it is required to set properly.

In Fig. 1, the pixel value selector 5 receives the pixel of notice delivered from the pixel value group sampler 2, Ymax and Ymin delivered from the candidate pixel value group sampler 3, and SELmax, SELmin delivered from the noise detector 4, and delivers any one of the pixel value of pixel of notice, Ymax and Ymin to the output terminal 1 on the basis of SELmax, SELmin.

Fig. 5 is a specific configuration of the pixel value selector 5, which is composed of one multiplexer 47. The multiplexer 47 receives the pixel value of the pixel of notice, Ymax and Ymin, and when both SELmax,and SELmin are both inactive, the pixel value b of the pixel of notice is delivered to the output terminal 6, and when SELmax is active and SELmin is inactive, Ymax is delivered to the output terminal 6, and when SELmax is inactive and SELmin is active, Ymin is delivered to the output terminal 6. As understood from the explanation of the noise detector 4, it is impossible that both SELmax and SELmin are active, owing to the condition of output of SELmax and SELmin.

Referring then to Fig. 8, the operation of the invention is described below. In Fig. 8a, all pixel values of P01, P11, P21, P14 are 100, the pixel value of P16 is 0, the pixel value of P18 is 70, and the pixel values of all other pixels are 50, and THmax and THmin are 30, for example.

Supposing the pixel of notice to be P11, Ymax delivered from the candidate pixel value group sampler 3 is 100, and Ymin is 50, and by the noise detector 4, DIFmax is 0 and DImin is -50, and Conditions 1, 2 are not established, and both SELmax and SELmin are inactive, and the pixel value of the pixel of notice P11 is delivered by the pixel value selector 5. When the pixel of notice is P01, P21, similarly, the pixel value of P01 or P21 is delivered, and the line segment in the vertical direction to the scanning line composed of P01, P11, P21 will be preserved. The same holds true also in the line segment in the oblique direction to the scanning line.

By the way, when the pixel of notice is P14, both Ymax and Ymin are 50, and DIFmax is 50 and DIFmin is -50, and only Condition 1 is established, and SELmax is active and SELmin is inactive, and the pixel value selector 50 delivers 50 as pixel value, and P14 is replaced to be flat with respect to the pixel value of the surrounding pixels. If the pixel of notice is P16, contrary to the operation when P14 was the pixel of notice, only Condition 2 is established, and SELmax is inactive and SELmin is active, and the pixel value selector 5 delivers 50 as pixel value, and P17 is also replaced so as to be flat with respect to the pixel value of the surrounding pixels.

Or when the pixel of notice is P18, DIFmax is 20 and DIFmin is -20, and either Condition 1 nor 2 is established, and the pixel value selector 5 directly delivers the pixel value of P18 as it is, and the detail portion included in the original video signal is preserved.

Finally, the output as shown in Fig. 8b is obtained, and only the pixel defect can be eliminated without spoiling the useful video information.

Incidentally, in the explanation of the pixel value group sampler 2, the horizontal delay unit is supposed to delay for the scanning time of one pixel portion only, but in single plate color imaging system, color filters may be disposed in stripes in the longitudinal direction. In such a case, by using horizontal delay units for delaying for the portion of the period of the color filters of the same color disposed on stripes, pixel defects can be removed from the output the solid-state image pickup device possessing striped configuration of color filters.

As a second embodiment, next is explained an example of removing pixel defects contained in the signal delivered from the solid-state pickup device having color filter arrangement on the basis of single chip CCD color difference method.

In the foregoing first embodiment, that the pixel defect can be removed by comparison between the pixel of notice and proximal pixel group is realized on the first condition that the pixel of notice and its proximal pixel group are of similar signal type (for example, comparison between brightness signals), and the second condition that the pixel defect occurs independently, and is low in correlation between defective pixel and proximal pixel. However, nothing has been considered about the color filter arrangement on the basis of the single chip CCD color difference method. In the single chip CCD color difference method, if the output of the solid-state image pickup device is entered in the device of the first embodiment directly, other type of color differential information is

contained among the proximal pixels, and the first condition is not established, and therefore it is necessary to sample preliminarily the brightness signal or color difference signal from the output of the solid-state pickup device. To obtain brightness signal or color difference signal, it is necessary to execute filter processing, but by passing through the filter, the noise component of the defective pixel diffuses into adjacent pixels, and the second condition is not established, and hence it was difficult to remove the noise in the first embodiment.

To generate brightness signal from the output of the solid-state pickup device having color filter array on the basis of the complete color differential linear sequential single chip CCD color system, generally it is generated by using a digital filter having the characteristic of $(1 + Z^{-1})$, and the color difference signal is generated by using a digital filter having the characteristic of $(1 - Z^{-1})$, and therefore the defect component is diffused in the scanning line direction. Since the range of pixels diffused by the filter is within one pixel adjacent in the scanning line direction, it is necessary to judge on the basis of the proximal pixel group excluding the adjacent pixel including defect out of the pixels before and after the pixel of notice. To remove the adjacent pixel containing defect, if the pixel of notice has a white spot, the larger one of the preceding and succeeding pixels is removed, and if the pixel of notice has a black spot, the smaller one of the preceding and succeeding pixels is removed. In other words, in the proximal pixel value group, the pixel value of the pixel existing at the closet position in the pixel group existing in the right direction on the same scanning line as the pixel of notice is supposed to be Pr, the pixel value of the pixel existing at the closest position in the pixel group existing in the left direction on the same scanning line to be P1, and the pixel value group excluding Pr, P1 from the proximal pixel value group to be Po, the white spot is judged by comparing the pixel of notice with the maximum value between the smaller one of Pr, P1 and Po, that is max (min (Pr, P1), Po). Likewise, the black spot is judged by comparing the pixel of notice with the minimum value between the larger one of Pr, P1 and Po, that is, min (max (Pr, P1), Po).

Fig. 1 is a schematic block diagram in a first embodiment of the invention, and the constitution is similar in the second embodiment, too, and the following explanation is given by reference to Fig. 1. In Fig. 1, in the second embodiment, the input terminal 1 is provided with brightness signal or color difference signal obtained by executing digital filter on the output of the solid-state pickup device having a color filter array on the basis of the complete color differential line sequential single chip CCD color system.

In Fig. 1, the candidate pixel value group sampler 3 delivers Ymax which is the maximum pixel value between the smaller pixel value of c4 and c5 and the remaining proximal pixel value group, and Ymin which is the minimum pixel value between the larger pixel value of c4 and c5 and the remaining proximal pixel value, from the pixel value group c of the proximal pixel groups delivered simultaneously from the pixel value group sampler 2. These Ymax and Ymin are candidate pixel value groups.

Fig. 6 is a specific constitutional example of the candidate pixel value group sampler 3. In Fig. 6, in conjunction with the explanation of the pixel value group sampler 2, this is to show an example of constitution of the candidate pixel value group sampler 3 in which the proximal pixel group is composed of 8 pixels, which is composed of maximum value circuit 51 and minimum value circuit 50 having two input terminal groups, and maximum value circuit 53 and minimum value circuit 52 having seven input terminal groups. The minimum value circuit 50 delivers the smaller one of the pixel values of c4 and c5 positioned one picture before and after the pixel of notice out of the proximal pixel value group c being entered, and the maximum value circuit 52 samples and delivers the maximum pixel value (Ymax) out of the output of the minimum value circuit 50 and the remaining proximal pixel value groups c1, c2, c3, c6, c7, c8. The maximum value circuit 51 delivers the largest one of the pixel values out of c4 and c5 positions one pixel before or after the pixel of notice among the proximal pixel value group c being entered, and the minimum value circuit 53 samples and delivers the minimum pixel value (Ymin) out of the output of the maximum value circuit 51 and the remaining pixel value groups c1, c2, c3, c6, c7, c8.

In Fig. 1, meanwhile, the constituent elements other than the candidate pixel value group sampler 3 are same as in the first embodiment, and the explanation is omitted.

Referring now to Fig. 9, the operation of the second embodiment of the invention is explained below. Fig. 9 is a partially cut-out view of the video signal in one field, in which the axes of the scanning line and the component vertical to the scanning line are plotted in the horizontal direction and depthwise direction, respectively, and the pixel values are shown in the vertical direction. Fig. 9a is an example of signal delivered from the solid-state pickup device having a color filter array on the basis of the complete color differential linear sequential single plate color system. For the simplicity of explanation, a monochromatic picture is shown. Fig. 9b shows a signal after execution of digital filter having the characteristic of $(1 + Z^{-1})$ on the signal in Fig. 9a, and this signal is fed to the input terminal 1 in Fig. 1. Fig. 9c shows a signal delivered from the output terminal 1 in Fig. 1 after input of the above signal.

In Fig. 9a, S01, S11, S21 express sharp line segments existing in the vertical direction to the scanning line, and S14 denotes a white spot and S16 a black

spot, and S18 expressed a fine detail included in the original picture. Here, all of pixel values of S01, S11, S21, S14 are 200, the pixel value of S16 is 0, the pixel value of S18 is 140, and all of pixel values of the remaining pixels are 100, for example, in Fig. 9b, by the digital filter, all pixel values of P01, P02, P11, P12, P21, P22, P14, P15 are 150, the pixel values of P16, P17 are 50, the pixel values of P18, P19 are 70, and all pixel values of the remaining pixels are 100.

Suppose THmax and THmin are both 30.

Assuming the pixel of notice to be P11, Ymax delivered from the candidate pixel value group detector 3 is 150 and Ymin is 100, and at the noise detector 4, DIFmax is 0 and DIFmin is -50, and neither Condition 1 nor 2 is established, and both SELmax and SELmin are inactive, and the pixel value of the pixel of notice P11 is delivered by the pixel value selector 5. When the pixel of notice is P01, P02, P12, P21 or P22, similarly, the pixel value of the pixel of notice is delivered, and the line segment in the vertical direction to the scanning line composed of P01, P02, P11, P12, P21, P22 is preserved. The same holds true also in the line segments in the oblique direction and horizontal direction to the scanning line.

Or if the pixel of notice is P14 or P15, both Ymax and Ymin are 100, and DIFmax is 50 while DIFmin is -50, and only Condition 1 is established, and SELmax is active and SELmin is inactive, and the pixel value selector 5 delivers 100 as the pixel value, so that P14 and P15 are replaced to be flat to pixel values of the surrounding pixels. When the pixel of notice is P16 or P17, contrary to the case in which P14 or P15 is the pixel of notice, only Condition 2 is established, and SELmax is inactive and SELmin is active, and the pixel value selector 5 delivers 100 as the pixel value, and therefore P16 and P17 are replaced so as to be flat to the pixel value of the surrounding pixels.

When the pixel of notice is P18, DIFmax is 20, and DIFmin is -20, and neither Condition 1 nor 2 is established, and the pixel value selector 5 delivers the pixel value of P18 directly, and the detail component included in the original video signal is preserved.

Finally the output as shown in Fig. 9c is obtained.

Or, in other method than the single plate color differential color method, if the pixel defect spreads in the horizontal direction, the pixel defects may be eliminated in such constitution as in the second embodiment.

Claims

1. A pixel defect removing circuit comprising:

   a pixel value group sampler for receiving a video signal, and delivering a pixel value of a pixel of notice noted at a certain time t and a proximal pixel value group consisting of pixel values of a group of proximal pixels adjacent to the pixel of notice two-dimensionally around the pixel of notice;

   a candidate pixel value group sampler for delivering a group of plural candidate pixel values as candidates of pixel values to be finally delivered from the circuit out of the proximal pixel values;

   a noise detector for performing an operation between the pixel value of the pixel of notice and the candidate pixel values to judge whether a pulse noise is included in the pixel of notice or not, and delivering a pixel selection signal to instruct which pixel value should be delivered out of the pixel value of the pixel of notice and the candidate pixel values on the basis of the result of judgement; and

   a pixel value selector for selecting and delivering either one pixel value out of the pixel value of the pixel of notice and the candidate pixel values on the basis of the pixel selection signal.

2. A pixel defect removing circuit of claim 1, wherein the pixel value group sampler passes an input signal through a multi-stage vertical delay circuit composed of cascade connection of n scanning line delay units for delaying for a time corresponding to one scanning line period, and picks up respective signals from input and output of the multi-stage vertical delay circuit and signal aires among the scanning line delay units, thereby creating m+1 video signals delayed in every one scanning line period, and each one of the generated m+1 video signals is passed into a multi-stage horizontal delay circuit composed of cascade connection of m pixel delay units for delaying for a time corresponding to a display period of x pixels, and each signal is taken out of input and output of n+1 multi-stage horizontal delay circuits and signal wires in the pixel delay units so as to obtain a group of $(n + 1)*(m + 1)$ pixel values adjacent two-dimensionally, and the pixel value of a specific position among the pixel value group is selected as the value of the pixel of notice, while the remaining pixel values are delivered as the proximal pixel value group, where x, m, n are integers of 1 or more.

3. A pixel defect removing circuit of claim 2, wherein the pixel value group sampler is $m = n = 2$.

4. A pixel defect removing circuit of claim 2, wherein both m and n are even numbers as for pixel value group sampler, and the position of the pixel of notice is position in the two-dimensional center of $(n + 1)*(m + 1)$ pixels.

5. A pixel defect removing circuit of claim 1, wherein the candidate pixel value group sampler delivers

at least two pixel values as the candidate pixel values, out of one having a maximum pixel value and one having a minimum pixel value out of the proximal pixel value group delivered from the pixel value group sampler.

6. A pixel defect removing circuit of claim 1, wherein the candidate pixel value group sampler delivers, supposing a pixel value of a pixel existing at the closest position in the pixel group existing in the right direction on a scanning line containing the pixel of notice, in the proximal pixel value group delivered from the pixel value group sampler, to be Pr, a pixel value of a pixel existing at the closet position in the pixel group existing in the left direction of the scanning line to be P1, and the pixel value group excluding Pr, Pr from the proximal pixel value group to be Po, at least two pixel values, as the candidate pixel values, that is, a maximum value between a smaller one of Pr, P1 and Po, or max (min (Pr, P1), Po), and a minimum value between a larger one of Pr, P1 and Po, or min (max (Pr, P1), Po).

7. A pixel defect removing circuit of claim 1, wherein the noise detector judges that a pulse noise is included in the pixel of notice when the value of the pixel of notice has a larger value than a specific threshold value as compared with Pmax, supposing a largest value in the candidate pixel value group to be Pmax, and delivers a pixel selection signal to instruct to select the Pmax among the candidate pixel value group.

8. A pixel defect removing circuit of claim 7, wherein the pixel value selector delivers Pmax when the pixel selection signal to instruct to select Pmax among the candidate pixel value group is entered, and otherwise delivers the pixel of notice as it is.

9. A pixel defect removing circuit of claim 1, wherein the noise detector judges that a pulse noise is contained in the pixel of notice when the pixel value of the pixel of notice has a smaller value than a specified threshold value as compared with Pmin, supposing a smallest value in the candidate pixel value group to be Pmin, and delivers the pixel selection signal for instructing to select Pmin among the candidate pixel value group.

10. A pixel defect removing circuit of claim 9, wherein the pixel value selector delivers Pmin when the pixel selection signal to instruct to select Pmin among the candidate pixel value group, and otherwise delivers the pixel of notice as it is.

Fig. 1

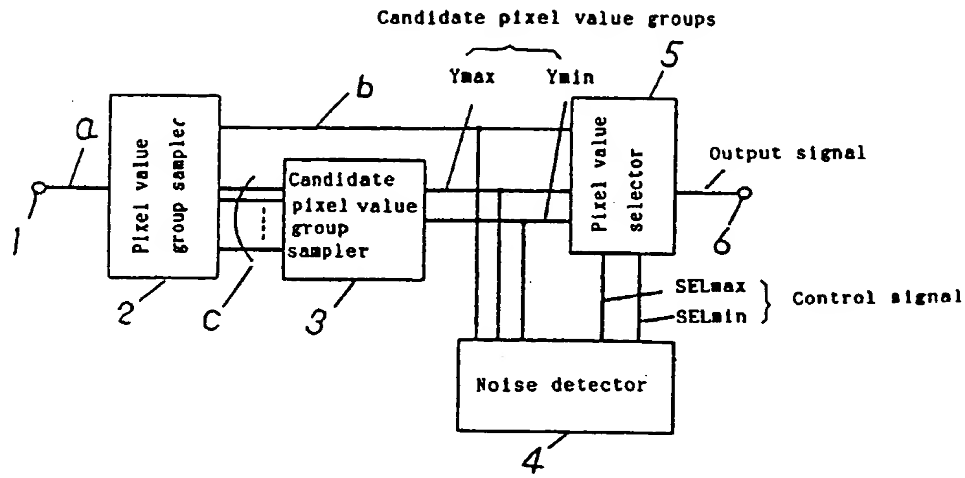

Candidate pixel value groups
Ymax
Ymin
5
b
a
Pixel value group sampler
Candidate pixel value group sampler
Pixel value selector
Output signal
1
6
2
c
3
SELmax
SELmin
Control signal
Noise detector
4

Fig. 2

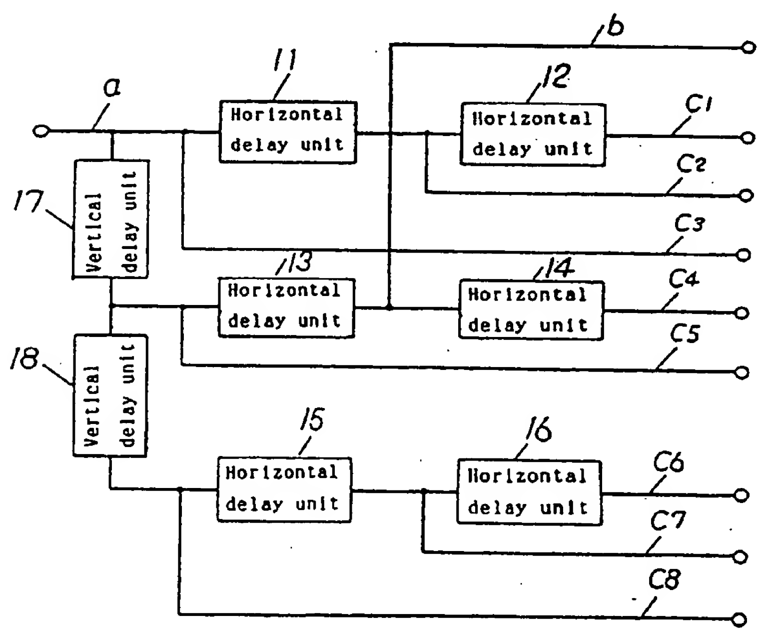

b
11
12
a
Horizontal delay unit
Horizontal delay unit
C1
C2
17
Vertical delay unit
C3
13
14
Horizontal delay unit
Horizontal delay unit
C4
C5
18
Vertical delay unit
15
16
Horizontal delay unit
Horizontal delay unit
C6
C7
C8

Fig. 3

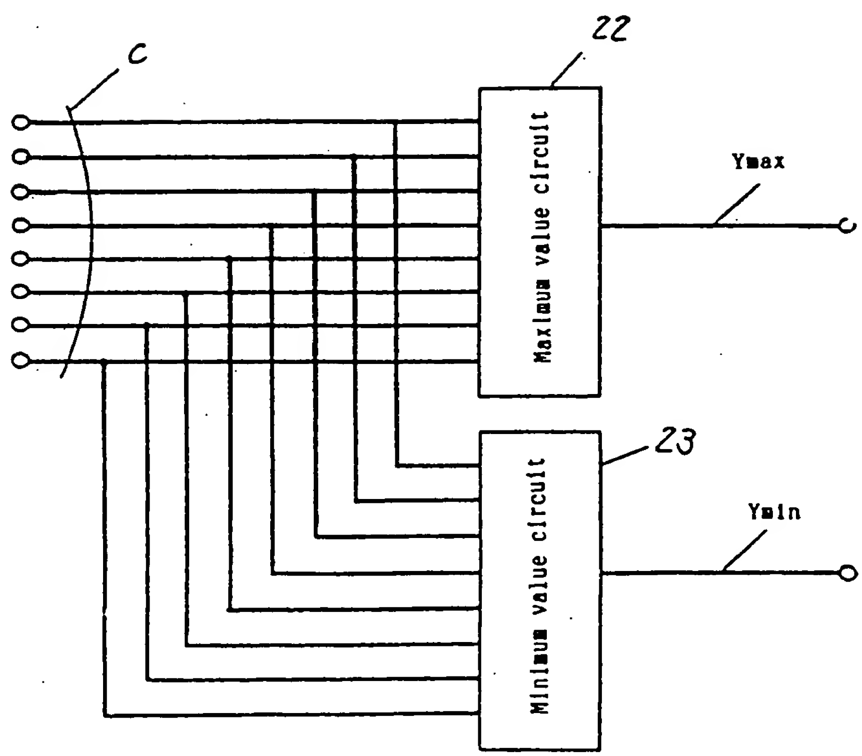

C
22
Maximum value circuit
Ymax
23
Minimum value circuit
Ymin

Fig. 4

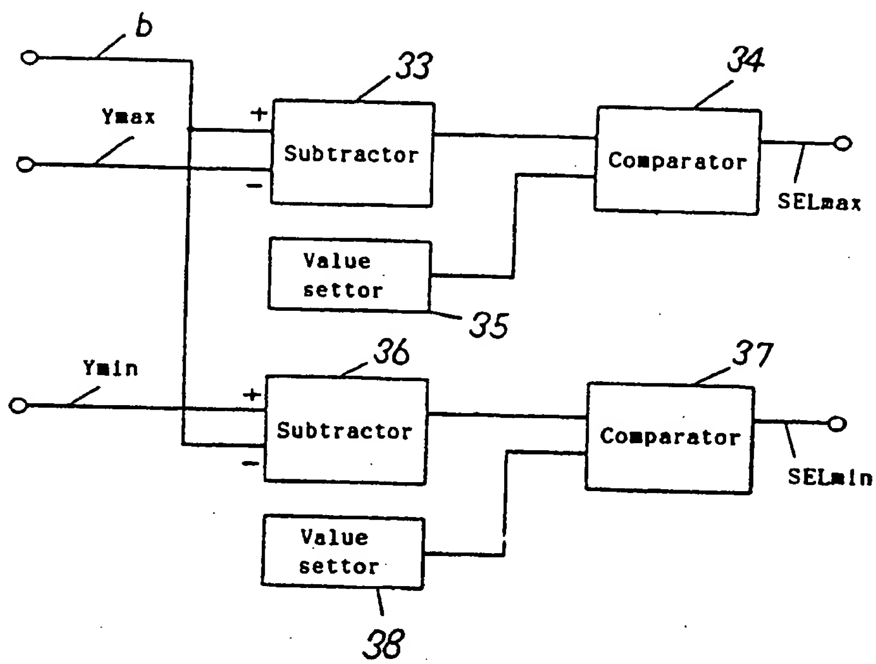

b
33
34
Ymax
+
Subtractor
Comparator
-
SELmax
Value
settor
35
36
37
Ymin
+
Subtractor
Comparator
-
SELmin
Value
settor
38

Fig. 5

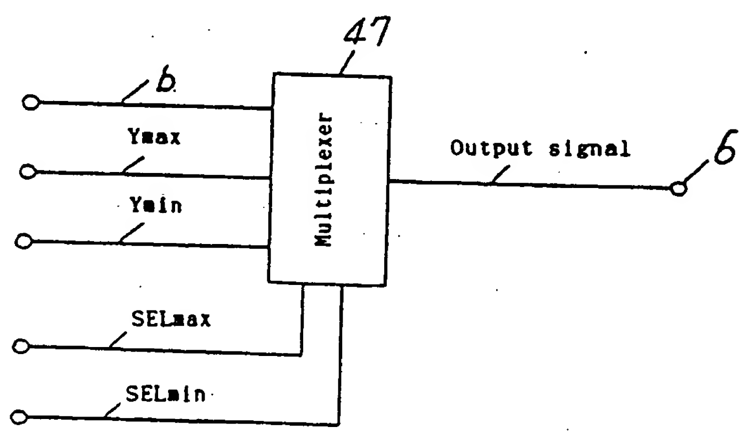

47
b
Ymax
Multiplexer
Output signal
6
Ymin
SELmax
SELmin

Fig. 6

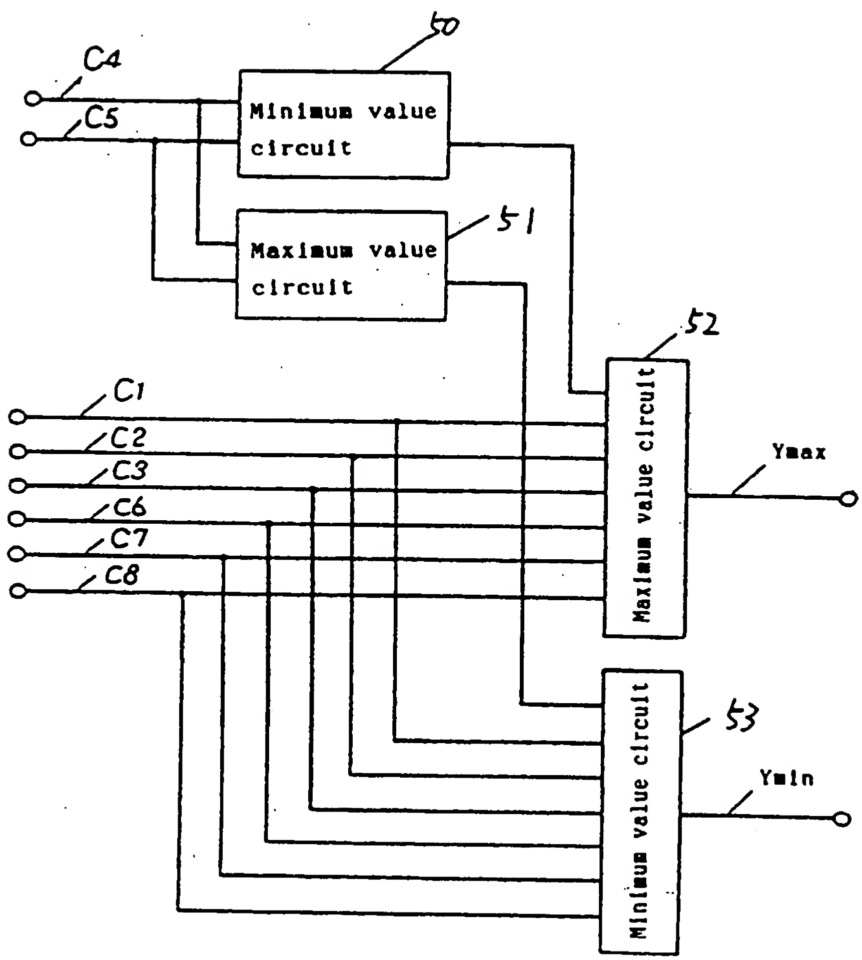

50
C4
C5
Minimum value circuit
51
Maximum value circuit
52
C1
C2
C3
C6
C7
C8
Maximum value circuit
Ymax
53
Minimum value circuit
Ymin

Fig. 7

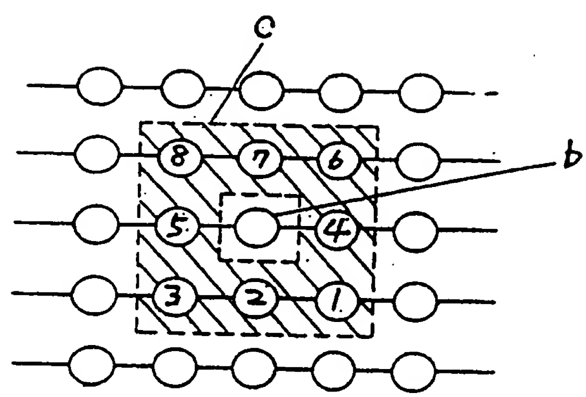
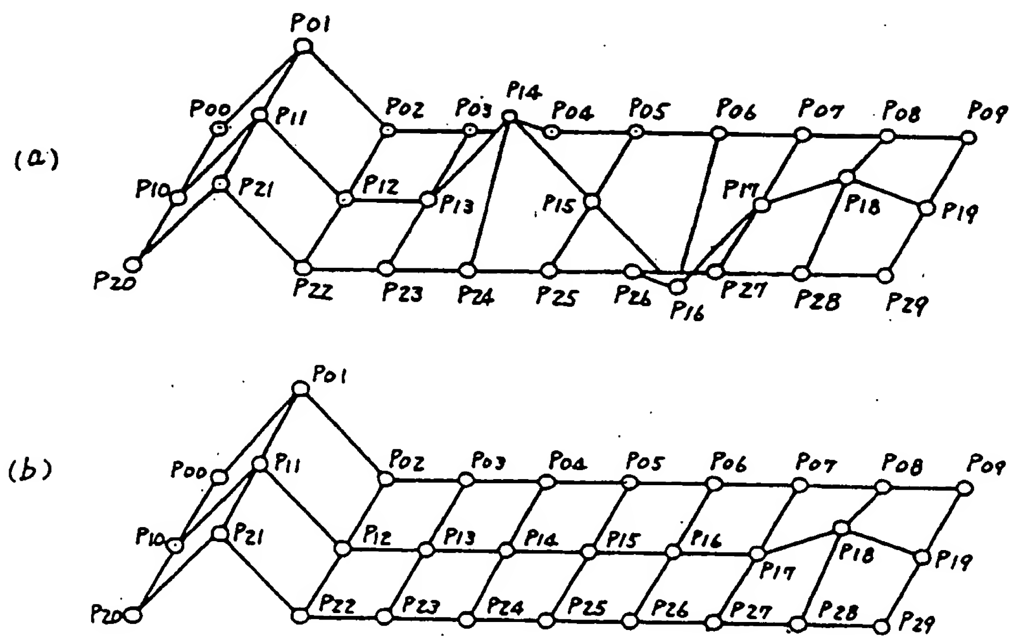


Fig. 8


(a)
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P00
P11
P02
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P14
P04
P05
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P13
P15
P17
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P19
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P22
P23
P24
P25
P26
P16
P27
P28
P29
(b)
P01
P00
P11
P02
P03
P04
P05
P06
P07
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P09
P10
P21
P12
P13
P14
P15
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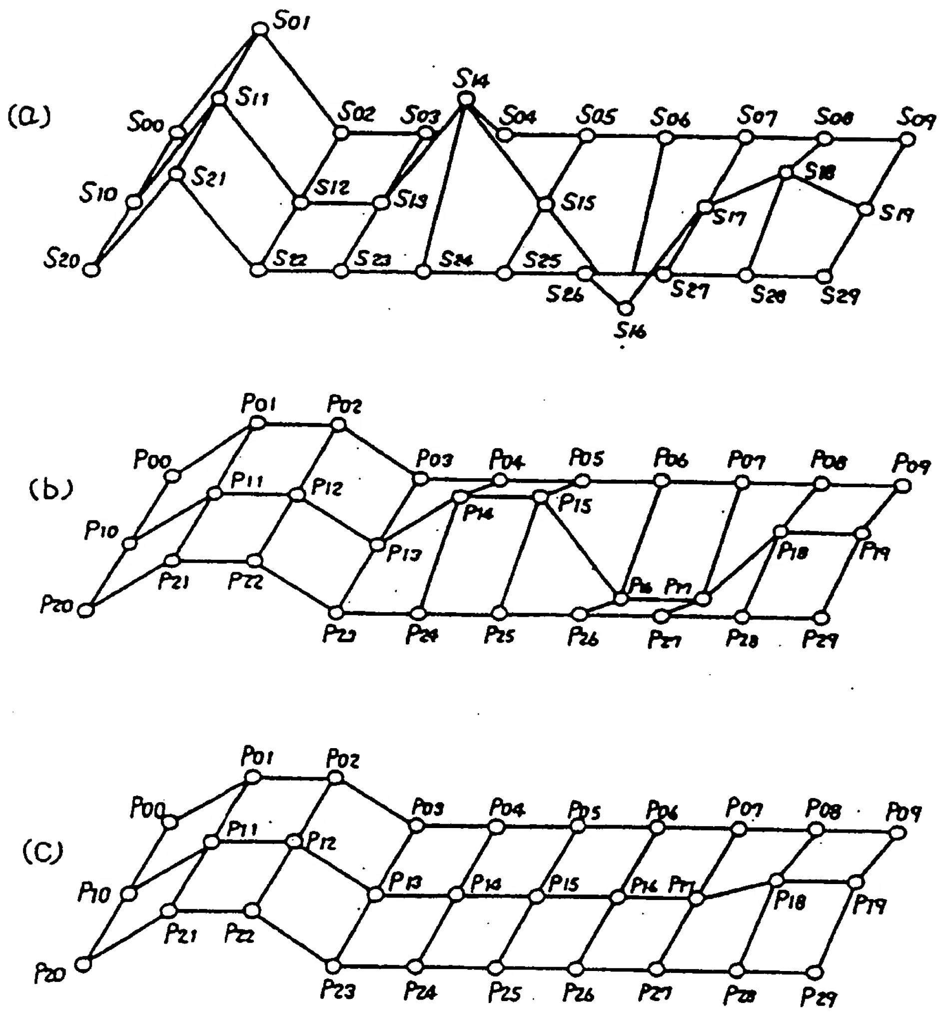
P29

Fig. 9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S27
S28
S29
S16
(b)
P01
P02
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P29
(c)
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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92300495.6

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE - A - 3 629 009 (SIEMENS) * Fig. 4-7; column 4, line 3 - column 5, line 35 * --	1,2	H 04 N 5/217
A	DE - A - 3 121 599 (ROBERT BOSCH) * Fig. 1,2; page 6, line 24 - page 13, line 2 * --	1,2	
A	US - A - 4 734 774 (SKAGGS) ----		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H 04 N 3/00
H 04 N 5/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	08-04-1992	BENISCHKA

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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